Environmental Economics

LEARNING OBJECTIVES

After completing this Unit, you should be able to:

- use relevant economic terminology and explain the relevance of economics in environmental management;
- describe the techniques used to assess costs and benefits as they pertain to environmental factors;
- explain the use of market-based instruments for pollution control.
- discuss the concepts of regional economics and ecological economics;

ECONOMICS AND THE ENVIRONMENT

In this Section, we will discuss the relationship between economics and the environment. However, before we do so, we will first introduce you to the concepts of economics and financial assessment. An understanding of the difference between these concepts is essential because one of the prerequisites of carrying

out a developmental project is the assessment of its economic feasibility and financial viability.

Economics describes the systems that humans have invented to facilitate the production, trade and distribution of goods and services to satisfy the needs of a community. It involves the exploitation of resources such as labour, materials, energy, water and land. The scope of economics is vast and goes beyond financial matters, i.e., dealings with money. Broadly, economic analysis can be categorised into macroeconomics and microeconomics.

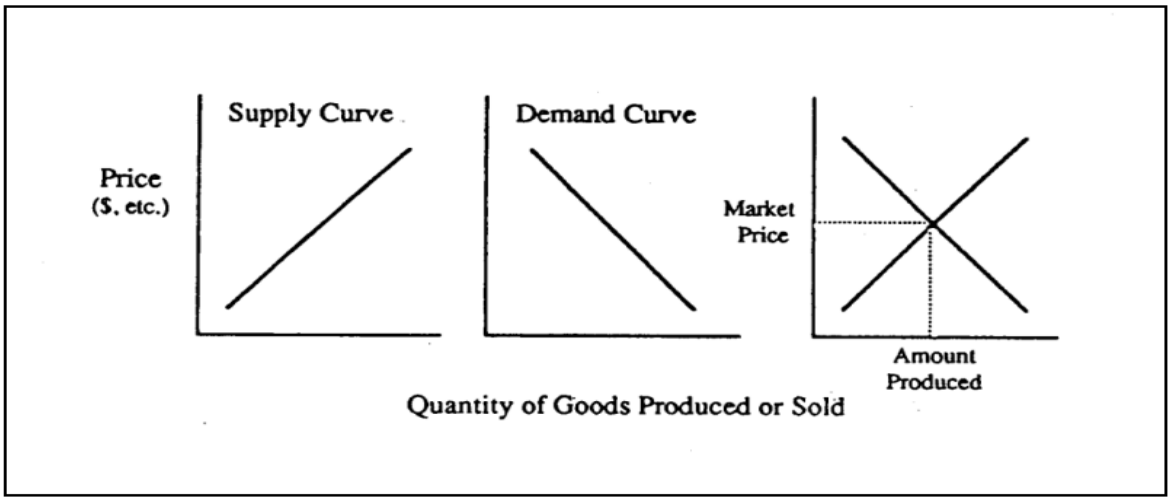
Macroeconomics

This refers to large-scale operations of the economy of a nation, a group of nations or the world and deals with issues such as overall production of goods and services, unemployment, money supply and inflation, national debt and balance of payments. Statistics on these and other factors are used as indicators to gauge the progress of an economy and to compare economics of different nations. A central theme running through all macroeconomic analysis is the balance between public (government) and private economic activity and the degree of government control.

Microeconomics

Microeconomics deals with the operations of a particular industry or a sector of a national economy (e.g., mining, electronics). It is mostly concerned with prices and production processes. The literature on microeconomics, generally, contains supply and demand curves. Figure 10.1 below illustrates one such supply-demand curve:

Supply and Demand Curves: An Illustration



As implied in Figure 10.1 above, the basic elements of supply-demand curves are:

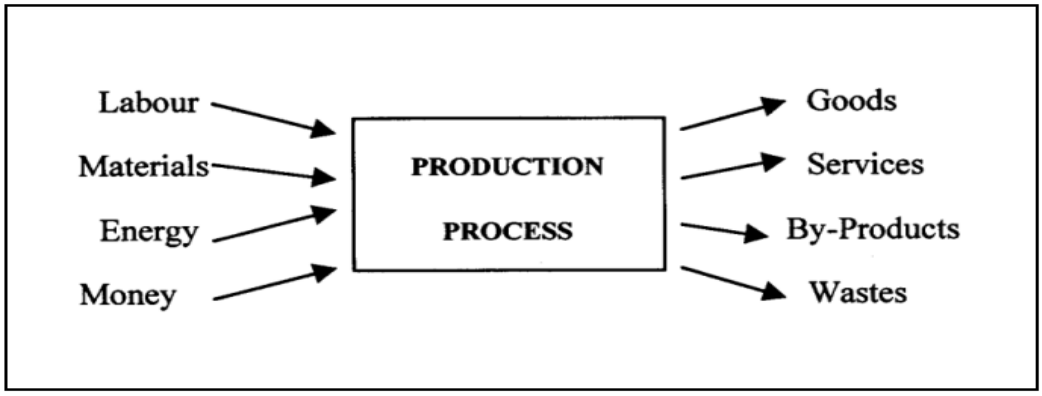
- The supply curve that expresses the attitude of producers of goods and services. (The higher the price for these, the more the producer will supply.)
- The demand curve that expresses the preferences of buyers or consumers. (The higher the price, the lower the quantity which will be bought.)
- Market price, which is an intersection point of supply and demand curves. (In a free economy, traders will be forced to bring the price and quantity produced to this equilibrium point, (i.e., market price.)

Many microeconomic studies are concerned with optimising production by finding the most efficient level of output, the best combination of goods to produce or the best combination of inputs. The cost of inputs and the selling price of outputs are usually used as indicators of efficiency. The objective may be to maximise gross benefits or profits, minimise costs, or to maximise net benefits (i.e., benefits - costs). Microeconomic analyses of this

nature are also relevant to projects such as the development of a factory or construction of a dam. Note that the level of production concerning large construction projects may be indicated by the production capacity, height of a dam or the number of lanes on a highway.

The production of goods and services represent an input-output process as shown in Figure 10.2 below:

Figure 10.2
Inputs and Outputs in Production



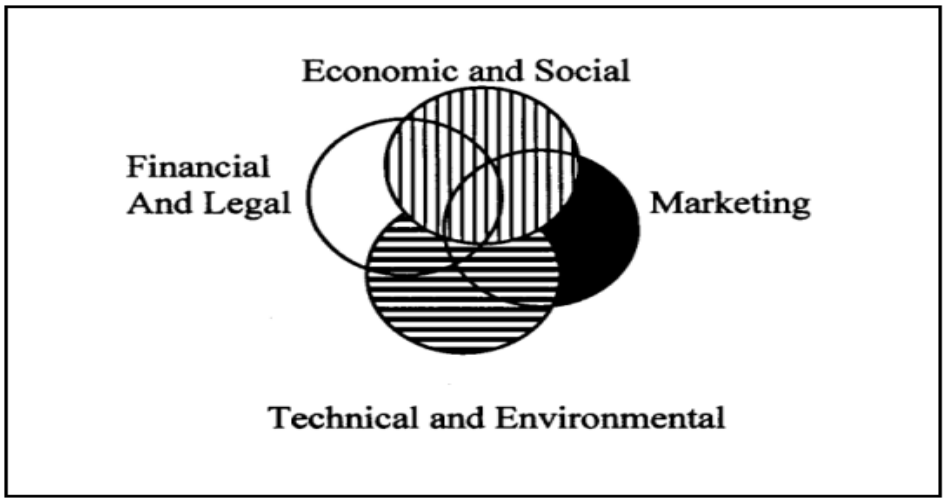
Analyses of the benefits of projects as a component of welfare economics emerged during the 19th century and gave fillip to the concept of *critical limit* in the exploitation of natural resources. Critical limit is the limit to which one can exploit the resources without causing loss to other stakeholders. And, beyond this limit, any new development will disadvantage somebody. Economists, later, put forward a principle that a project was justified if its benefits exceeded the amount needed to compensate the persons who suffered losses, even when no compensation was actually paid. This theory was implemented practically in the methods of cost-benefit analysis.

A sub-set of economics is finance. But, it has its own procedures and philosophies. It is the domain of an accountant or a lawyer

rather than that of an economist. It deals with diverse things by valuing them in terms of money. Put differently, funds are invested in developments and industrial activities, and income is derived from sales or fees for service. Records of expenditures and incomes must be kept in order that managers can control the operations efficiently and report to company shareholders and government regulators such as taxation offices, and provide a database for future planning. Facilities such as cost-control systems are, therefore, required and documents such as balance sheets and income statements must be prepared. There is also a legal responsibility for companies to prepare accounting documents in compliance with certain conventions.

Financial assessments can be performed in a similar manner to economic assessments, concentrating on financial cash flows. They usually involve the preparation of projected or pro-forma budgets, income statements and other documents.

Project Assessment: Sectoral Relationship



How are environmental values to be considered in an economic context? We will discuss this issue

Environmental economics: an introduction

The study of economy-ecology interactions has gone far, even within the limits imposed by the discipline of economics. First, it is understood that economic activity uses natural resources and also returns waste to nature, and more importantly, the scale of that activity is determined independently of the rate of replacement of resources or waste absorption capacity of the environment. At low levels of economic activity, the asymmetry goes unnoticed because the inputs required for extraction are small. Traditional microeconomics treats environmental effects as externalities of production or consumption (Pigou, 1932 and Ayres & Kneese, 1969). Beyond certain scales of economic activity, the pervasive nature of these externalities and limits on the waste assimilative capacity of environmental sinks results in the need for such residues to be treated as part of the materials balancing problem in the economy.

Environmental economics attempts to bring complex environmental factors into conventional economic analysis. At present, there are some problems with this. Since unintended environmental effects are secondary to the main purpose of a project, there is no market in which values can be set. Such effects are often called externalities, as owners or developers of

projects see them as being outside their concerns. Also, there is disagreement about their importance or severity. Finally, as development has occurred at an unprecedented rate in recent times, and environmental concerns are relatively new, there is a lack of information on which to base judgements.

The new environmental economics emphasises that:

- Economic systems must operate within the environment. Environmental values should be included in economic analysis, for example, by defining costs of environmental damages and rents for use of the environment.
- Present indicators of economic growth and wealth, such as the Gross Domestic Product (GDP) used in national accounting, are based on market prices and commonly ignore environmental and quality of life factors. They are biased towards developments, which produce tradable goods rather than less tangible benefits. It is necessary to build environmental capital as well as human-made forms of wealth.
- Many economic and financial assessments are flawed because they reflect only the viewpoint of the developer, ignoring external groups who may be harmed. From the public viewpoint, it is necessary to assess effects on everyone, particularly socially deprived groups who have little money and influence.
- There is an issue of equity between the present generation and future ones. Pursuit of short-term gains and consumption

> may cause lasting harm to posterity, especially if unique environments and resources are destroyed. It follows that renewable resources should be favoured over non-renewable ones. This question of intergenerational concern is one of the main arguments for sustainable development.

Optimal control methods analyse the constraints imposed on consumption growth by nature and the rates of regeneration of environmental resources. An extended analysis takes into account the multiple functions that environmental resources perform in relation to human survival and economic activity. The conditions of sustainable economic developments are derived in this framework. Further, if the resource stock has an amenity value and provides utility, the rate of extraction is more gradual and imposes limits on economic growth.

Barbier (1989) and Barbier & Markandaya (1989) suggests that an essential criterion for sustainable development is maximising the net benefits of economic development subject to maintaining the services and the quality of natural resources over time. A minimum viable level of the stock of environmental assets is built in as a constraint in addition to restrictions on rates of degradation, use of assets and levels of regeneration. This demonstrated that a low initial level of environmental quality results in environmentally unsustainable development. The discount rate makes the strategy of increased present consumption optimal. This implies that an economy with a high discount rate requires a higher initial level of environmental quality to avoid a growth path that is environmentally unsustainable.

Having introduced the concept of environmental economics, we will next discuss the techniques for valuation of environmental costs, benefits and also economic instruments (incentives and penalties) available for environmental management. But, before

we do so, let us touch upon the concept of monetary values

Environmental costs and benefits

All assessments involve the identification of favourable and unfavourable effects. In economic terms, these are expressed as monetary costs or benefits and are estimated by using:

(i) past experience and results from activities similar to those proposed;

(ii) databases and processed information from bodies such as Statistical Bureau and Industry Associations;

(iii) Informal information such as newspaper reports.

Costs

Costs of works can be determined from prices in past contracts and a company's cost accounting records. Market prices for goods can be found from records in statistical digests and trade journals. It is, however, likely that suitable data may not be available because a project is unprecedented, involves aspects that have never been tried before or is being implemented in a new environment. In such circumstances, effects and their costs and benefits must be estimated by special studies. These can be:

(i) Surveys of existing systems (e.g., a land survey of a planned highway route, an opinion survey of persons affected by aircraft noise from a new airport, etc.).

(ii) Models of non-existent systems (e.g., any system which is designed, but not yet built).

Costs can be classified in many different ways including the following:

- **Capital or first costs:** These are costs associated with the construction or implementation phase of a project, while operation, maintenance and replacement (OMR) costs relate to its ongoing operation. Sunk costs are costs incurred before the commencement of a project. Let us explain this further. For a project involving construction and operation of a large petrol station beside a motorway, the site preparation and construction of buildings will be among the capital costs. OMR costs will include the wages of employees, costs of petrol, electricity, etc. If the developer already owned the site prior to the decision to build the petrol station, it could be regarded as a *sunk cost*.
- **Direct costs:** These are costs attributable to some specific operation or component of a project, as opposed to general costs or overheads. For example, for cost-control purposes, a factory making 14 kinds of plastic products, could allocate costs to each product. However, items such as salaries of managers and office staff, water supply and building maintenance cannot be divided in this way, and must be regarded as overheads.
- **Variable costs:** These costs depend on the quantity of some items produced, unlike fixed costs that are independent of quantity (e.g., the cost of raw materials used by a shoe factory is variable, depending on its production, while the costs of advertising, rent and accounting are relatively fixed).
- **Marginal costs:** Marginal costs are the costs of adding one additional unit to a project. In the production of goods, costs vary with the amount of production, due to changes in the ratios of variable and fixed costs, shortages of inputs and efficiencies or inefficiencies at different levels of production. If

total costs are plotted against project output or scale, the marginal cost is the slope of this line. As production levels increase, marginal or unit costs decrease at first, due to economics of scale. They then reach a point of lowest cost, and then increase due to shortages of materials and other inputs.

- **Incremental costs:** These represent the differences in costs between two alternative projects or levels of project scale. Comparisons in cost-benefit analyses are made on the basis of incremental costs and benefits. For example, if a decision is made to connect two suburbs of a city by a light railway, and there are two possible routes, the incremental costs are simply the differences between the costs of these alternatives.
- **Opportunity costs:** These are the benefits foregone from some alternative investment when a particular project is adopted. For example, if irrigation water is to be supplied to a group of farms, the farmers will benefit from the increased production from conversion to irrigated agriculture. However, they will lose the ability to dry-farm the land. The real benefit is the difference between the benefits derived from irrigation and dry-land farming. Put differently, opportunity costs in this instance refer to the benefits from dry-land farming, which are lost.

We will next discuss a tool used in environmental economics, viz., environmental taxes. The use of taxation is an important tool for seeking environmental management goals.

Environmental taxes

Capra (1997) suggested that one of the most effective ways of countering environmental damage and supporting sustainable development would be to shift the tax burden from income to *eco-taxes*. An eco-tax can be added to products, energy, services and

materials to reflect true costs. This means that the consumer pays. While there have been national measures for some time, the interest in *green taxation* on an international scale is recent (and still mainly theoretical), which is triggered by increasing transboundary pollution, competition for internationally shared resources and the threat of global environmental change.

The function of green taxes is not to raise revenue for government but rather to provide participants in the marketplace with accurate information about true costs. For example, a tax on CFCs reflects their impact on ozone (Farber, et al., 1995). Green taxes counter the pursuit of lower prices by externalising the true costs, ensuring that the purchaser is aware of the costs of environmental impacts. It is important that attempts to integrate external costs of production into prices do not burden the poor or punish the middle classes. The aim instead is to give people and companies incentives to invent, innovate and respond to environmental challenges (Repetto, et al., 1992). Green taxation should encourage manufacturers to seek to reduce waste and other environmental damage to keep down their costs and thus prices to the purchaser, i.e., there is an incentive to improve environmental practice. Taxation is also becoming an important tool in the quest for sustainable development (Barrow, 1999).

There are a number of taxation approaches that have potential for controlling global climate change and these include trade able emission quotas; carbon (emissions) tax; energy use tax; taxation associated with technology transfers; reduced taxation for providing carbon sinks, etc. We will discuss two of them here.

Pigouvian taxes

Individuals who consider only their own private costs and private benefits will do too much of any activity that generates negative

externalities and too little of one that generates positive externalities

When an activity generates both positive and negative externalities, private and social welfare will coincide only in the unlikely event that these opposing effects happen to offset one of these.

When externalities are present, the individual pursuit of self-interest rarely results in maximum social welfare. When it does not, we have an outcome that is, by definition, inefficient. This, in turn, means that it is possible to rearrange things in a way that makes at least some people better off without harming others in the process. There is an economic rationale for some form of government intervention in markets where externalities are prevalent.

How can we take into account the third party effects that necessarily arise? The key is to internalise the externalities that exist, i.e., make the firms and consumers that create the externalities take them into account when making their decisions. The classic way to adjust for externalities is to tax those who create negative externalities. This is sometimes known as making the polluter pay or introducing Pigouvian Taxes.

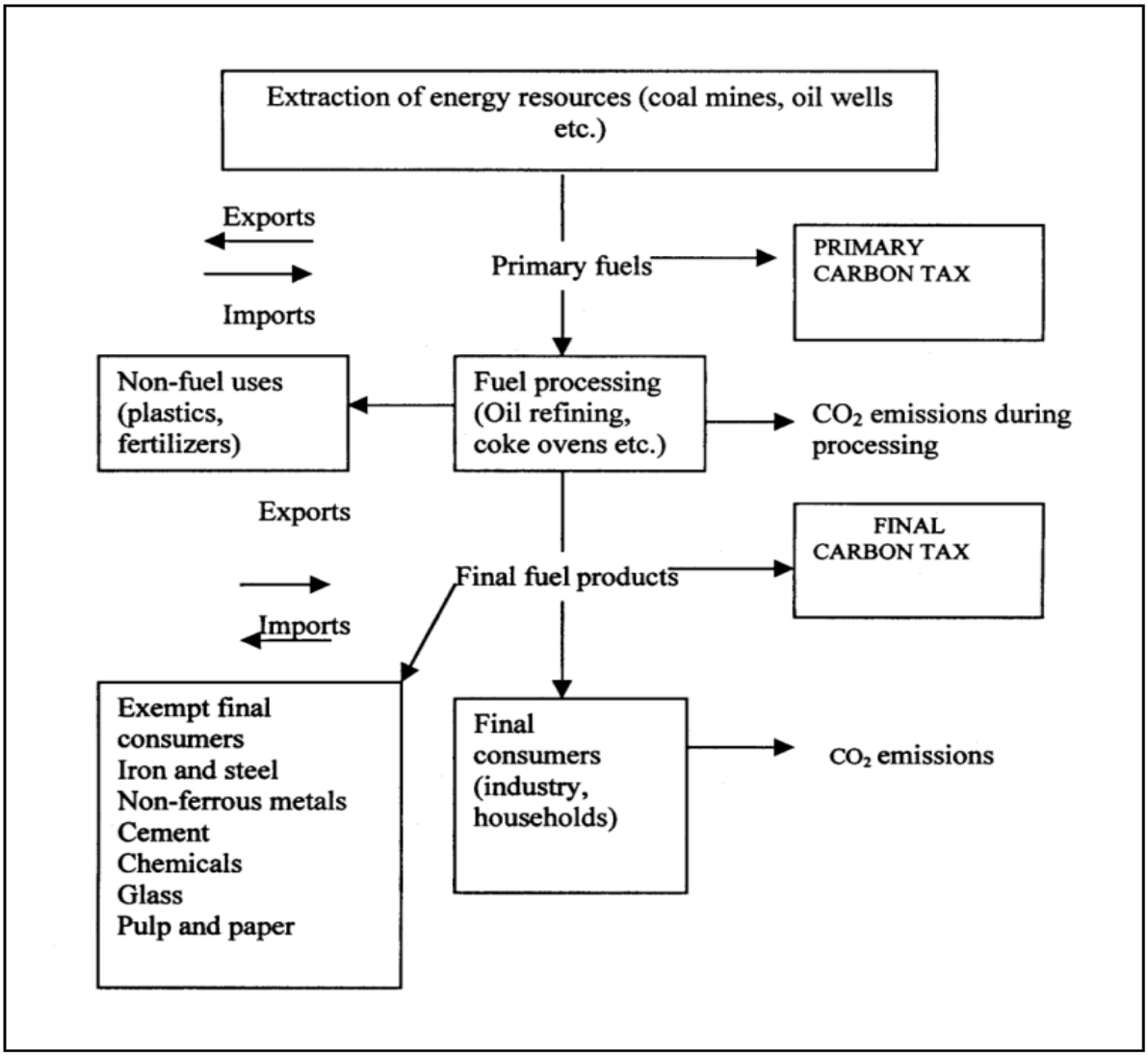
Carbon emission taxes

Ideally, a tax to control atmospheric emissions of carbon dioxide may be levied directly on the individuals or firms who are responsible for the emissions and may be based directly on the amount of carbon dioxide emitted. There are too many sources of emissions for direct measurement of emissions to be practicable. In practice, therefore, carbon taxes take the form of a tax on the

carbon content of fuels, intended as a proxy for the carbon emission, which results from the combustion of these fuels. In some European countries (Sweden, Norway, Finland, the Netherlands and Denmark), where there is a policy of carbon tax, carbon taxes have taken the form of extended systems of fuel excises. Rates of taxes are defined separately for each fuel, in terms of fuel quantities, and relative tax levels on different fuels are set so as to equate the implicit rate of tax per unit of carbon across fuels. This requirement is, however, not always observed. In Denmark and Norway, for example, some fuels are not subject to the carbon tax. Also, the level of tax can vary across types of energy users. In Sweden and the Netherlands, for example, much lower rates of tax apply to industrial energy users than to energy use by private households. Most of the carbon taxes actually implemented in these countries have provisions to exempt firms or sectors, which are particularly exposed to international competition.

There are two schemes of carbon taxation: *primary carbon tax* (levied on primary fuels such as crude oil, coal and gas where they are mined, extracted or imported) and *final carbon tax* (levied on final fuel products such as coke, anthracite and four-star petrol sold to industrial users or households). Figure 10.4 below illustrates the primary and final carbon taxes:

Primary and Final Carbon Taxes



Problems with environmental taxes

The problems with environmental taxes include the following:

- If taxation is too high, in part as a result of the problem of assigning accurate monetary values to the external costs created by producers and consumers, the outcome can be the expansion of gray markets where producers and consumers try to avoid the taxes. For example, one of the effects of the

landfill tax has been an explosion in fly-tipping as producers seek to avoid paying the tax.

- Taxation may not be directed correctly, if it is hard to pinpoint precisely who is causing the pollution. This is the case along rivers where several industrial plants might be emitting effluents. Should producers be subject to a consistent tax regime when some are more at risk of polluting than others?
- Producers may be able to pass on the burden of the tax to the consumers, if the demand for the good is inelastic or the supply of the product is elastic.
- Higher taxes may cause cost-push inflation which itself may have detrimental effects on the economy (e.g., it may affect those people who have had nothing to do with the pollution itself).
- Taxes have a regressive effect on people on low incomes (e.g., the increased real level of duty on cigarettes and alcohol and the impact this has on households on below average incomes).

10.1.4 Environmental accounting

Environmental auditing has been applied to eco-audits, stock taking, eco-review, eco-survey, etc. (Barrow, 1999). Environmental quality evaluations and environmental accounts systems collect data on the environment and resources to try and show the state of an area (or sea like the Baltic or Aegean). Most of these accounting procedures treat the environment as natural capital and try to measure its depletion or enhancement. Valuing the environmental features in monetary terms can be, admittedly, difficult.

The foundation for the accounting procedures has often been the UN model of Standard National Accounts, usually with *satellite accounts* added for environmental items. Some call these types as accounts *environmentally adjusted national accounts*. These accounts seek to establish the stocks of resources, value of environmental features and their use over time. National environmental accounts systems, i.e., new systems of national accounts, green accounts patrimonial accounts or state of the environment accounts) have been developed to assist with data gathering and storage and to value environment and natural resources.

Environmental accounting systems seek to set out a region's environmental, social and economic assets, and can be used to assess whether economic development is consistent with sustainable development, or to help ensure optimal use of natural resources and environment. For example, a natural resource accounting system can help the manager establish the percentage of, say, mineral exploitation profits to invest in long-term sustainability so that a region or country does not suffer a boom or decline. In practice, being able to make such investments depends on the type of government, people's attitudes and the persuasiveness of environmental management. Natural resource accounts can show the linkages between the environment and the economy, may be useful for forecasting and can establish the habitats, etc., that are of importance.